CHAPTER 9—BIOMEDICAL RESEARCH FACILITIES

HIGHLIGHTS

- In 1998, the Nation's 908 biomedical research-performing institutions had 73.3 million net assignable square feet of biomedical research space. Slightly more than half of all the biomedical research space (53 percent or 38.9 million NASF) was in the biological sciences; the other 47 percent or 34.4 million NASF was in the medical sciences (table 9-1).
- Overall, 65 percent of institutions with research space in the biological sciences and 52 percent of institutions with research space in the medical sciences reported that the amount of biomedical research space they had was inadequate to meet their current research commitments (table 9-2).
- In fiscal years 1996 and 1997, 172 biomedical research-performing institutions started construction on 7.4 million NASF of biomedical research space. They committed $2.2 billion to new construction projects costing over $100,000 (table 9-3).
- In fiscal years 1996 and 1997, 379 biomedical research-performing institutions started repair/renovation projects on 9.0 million NASF of biomedical research space. They committed $770 million to new repair/renovation projects costing over $100,000 (table 9-4).
- In 1998, biomedical research-performing institutions reported $5.6 billion in combined capital projects (construction and repair renovation) that had to be deferred because of insufficient funds. Construction projects account for 64 percent ($3.6 billion) of the total deferred capital project costs (both included and not included in an institutional plan) (table 9-7).

INTRODUCTION

Biomedical research facilities are a critical component of the Nation's science and engineering research system. Consequently, NSF and the National Institutes of Health (NIH) have collected data on the amount, quality, and condition of research space in the biological and medical sciences in the Nation's biomedical research-performing institutions since the inception of the *Facilities* survey in 1986. These research facilities are not only located at academic institutions, but also in research hospitals and nonprofit research organizations.

This chapter looks at the top 50 academic institutions in science and engineering research expenditures instead of the top 100. In addition, because of their importance in producing black biomedical researchers and physicians, the 29 original HBCUs are pulled out for separate analysis.

Colleges and universities with an affiliated medical school are counted as both a college or university and as a medical school in all tables reporting the number of institutions. Their biological and medical science research space—existing, needed, constructed, deferred, and repaired/renovated—and the associated expenditures are divided between the college or university and the medical school categories depending on whether the research space or capital project was designated as inside or outside a medical school. That is, while the institution is counted twice, its research space and associated costs are not.

Several tables present the survey results for the biological and medical sciences separately. The "biological sciences" includes all institutions with research space inside or outside of medical schools. Similarly, "medical sciences" includes all institutions with research space inside or outside of medical schools.

FINDINGS

AMOUNT OF BIOMEDICAL RESEARCH SPACE

In 1998, the Nation's 908 biomedical research-performing institutions had 73.3 million net assignable square feet of biomedical research space. This is 9 percent or 5.9 million NASF more than they had in 1996 and 41 percent or 21.4 million NASF more than they had a decade ago (table 9-1).

Slightly more than half of all the biomedical research space (53 percent or 38.9 million NASF) was in the biological sciences; the other 47 percent or 34.4 million

Table 9-1. Amount of biomedical research space by institution type and field: 1988–98

Indicator	Academic institutions				Research organizations	Hospitals	All institutions		
	Colleges/universities			Medical schools[3]			Total	Field	
	Top 50	Other doctorate-granting	Non-doctorate-granting					Biological sciences	Medical sciences
Number of biomedical institutions, 1998[1]	49 [2]	273	246	145	171	125	908	752	503
Amount of research space [NASF in millions]									
1988	10.2	10.0	1.1	21.9	4.4	4.2	51.9	28.2	23.7
1990	10.4	10.9	1.3	23.3	4.8	4.5	55.2	31.0	24.3
1992	10.7	11.3	1.6	26.8	5.1	4.6	59.7	32.4	27.3
1994	10.9	10.6	1.0	27.7	6.4	5.4	62.5	34.1	28.4
1996	12.2	12.1	1.7	28.5	6.6	6.2	67.4	35.9	31.5
1998	12.9	11.6	1.9	29.8	9.5	7.6	73.3	38.9	34.4

[1] The number of institutions across institution types does not sum to grand totals because many institutions contain both a college/university and a medical school. In grand totals, medical schools are counted as separate institutions only if they are not affiliated with a college or university.

[2] Among the top 50 research-performing institutions, one is a medical school and is included in the count for medical schools.

[3] The number of medical schools is based on the sum of the weights of institutions with medical school research space. Medical schools were not an explicit strata in the sampling scheme. Thus, this number may not reflect the actual number of medical schools in the universe.

KEY: NASF = net assignable square feet.

NOTE: Components may not add to totals due to rounding.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

NASF was in the medical sciences. The amount of research space in each field grew by 10.7 million NASF over the decade, with the biological sciences experiencing a 38-percent increase in research space (from 28.2 million to 38.9 million NASF) and the medical sciences experiencing a 45-percent increase (from 23.7 million to 34.4 million NASF).

More than three quarters of all the biomedical research space (77 percent or 56.2 million NASF) was located in academic institutions. Slightly more than half of this space (29.8 million NASF) was located in medical schools, with the remaining 26.4 million NASF located in research-performing colleges and universities. Nonprofit research organizations accounted for 13 percent (9.5 million NASF) of all biomedical research space, while research hospitals accounted for 10 percent (7.6 million NASF).

Between 1988 and 1998, every type of institution, except research hospitals, experienced an appreciable increase in biomedical research space:

- At the top 50 institutions, the amount of biomedical research space increased by 26 percent (from 10.2 million to 12.9 million NASF);
- At other doctorate-granting institutions, the amount of biomedical research space increased by 16 percent (from 10.0 million to 11.6 million NASF);
- At nondoctorate-granting institutions, the amount of biomedical research space increased by 73 percent (from 1.1 million to 1.9 million NASF);
- At medical schools, the amount of biomedical research space increased by 36 percent (from 21.9 million to 29.8 million NASF); and
- At nonprofit research organizations, the amount of biomedical research space increased by 116 percent (from 4.4 million to 9.5 million NASF).

Adequacy of the Amount of Biomedical Research Space and Its Condition

Overall, 65 percent of institutions with research space in the biological sciences and 52 percent of institutions with research space in the medical sciences reported that the amount of biomedical research space they had was inadequate to meet their current research commitments:

- Among colleges and universities, 64 percent rated their biological sciences research space as inadequate, while 54 percent rated their medical sciences research space as inadequate;
- Among medical schools, 70 percent rated their biological sciences research space as inadequate, while 67 percent rated their medical sciences research space as inadequate;
- Among nonprofit research organizations, 73 percent rated their biological sciences research space as inadequate, while 27 percent rated their medical sciences research space as inadequate; and
- Among research hospitals, 26 percent rated their biological sciences research space as inadequate, while 52 percent rated their medical sciences research space as inadequate (table 9-2).

The percentage of institutions with biomedical research space reporting inadequate amounts of research space in the biological sciences increased between 1996 and 1998 from 47 to 65 percent of institutions. During this time period, the percentage of institutions reporting inadequate amounts of research space in the biological sciences increased at three types of institutions: colleges and universities, medical schools, and nonprofit research organizations. By contrast, the percentage of institutions reporting inadequate amounts of research space in the medical sciences remained essentially the same between 1996 (51 percent) and 1998 (52 percent).

Overall, the institutions reported that they needed an additional 9.0 million NASF of research space in the biological sciences or 23 percent more than they had in order to meet their research commitments. At the same time, they reported that they needed an additional 7.1 million NASF of research space in the medical sciences or 21 percent more than they had:

- Colleges and universities reported needing 25 percent more research space in the biological sciences (4.8 million NASF) and 27 percent more research space in the medical sciences (1.9 million NASF);
- Medical schools reported needing 21 percent more research space in the biological sciences (2.5 million NASF) and 22 percent more research space in the medical sciences (4.0 million NASF);
- Nonprofit research organizations reported needing 22 percent more research space in the biological sciences (1.4 million NASF) and 18 percent more research space in the medical sciences (0.6 million NASF); and
- Research hospitals reported needing 19 percent more research space in the biological sciences (0.3 million NASF) and 10 percent more research space in the medical sciences (0.6 million NASF).

Less than half (48 percent or 18.7 million NASF) of research space in the biological sciences was rated as "suitable for the most scientifically competitive research," and less than half (43 percent or 14.8 million NASF) of research space in the medical sciences was rated this way. The percentage of the different types of institutions rating their research space as being in the highest quality condition is as follows (see table E9-1 for total NASF by field by institution type):

- Colleges and universities rated 40 percent (7.6 million NASF) of research space in the biological sciences and 32 percent (2.2 million NASF) of research space in the medical sciences as suitable for the most scientifically sophisticated research;
- Medical schools rated 49 percent (5.9 million NASF) of research space in the biological sciences and 44 percent (7.7 million NASF) of research space in the medical sciences as being in this condition;
- Nonprofit research organizations rated 67 percent (4.3 million NASF) of research space in the biological sciences and 65 percent (2.1 million NASF) of research space in the medical sciences as being in this condition;

Table 9-2. Adequacy of the amount of biomedical research space and its condition by institution type and field: 1988–98

	Biological sciences					Medical sciences				
		Academic institutions		Research			Academic Institutions		Research	
	Total	Colleges/ universities	Medical schools[1]	organi-zations	Hospitals	Total	Colleges/ universities	Medical schools[2]	organi-zations	Hospitals
Number of biomedical institutions with existing or nonexistent but needed research space, 1998[1]	764	569	127	98	44	521	269	127	98	92
Adequacy of current amount of research space [percentage of institutions reporting current space inadequate]										
1988	45	46	49	37	43	41	40	47	23	44
1990	41	43	54	14	30	44	47	59	9	39
1992	32	37	36	13	8	31	36	42	14	22
1994	32	43	43	13	30	41	43	49	29	42
1996	47	53	46	32	14	51	57	66	26	32
1998	65	64	70	73	26	52	54	67	27	52
Amount of research space needed [NASF in millions]										
Total research space	38.9	19.4	11.6	6.4	1.5	34.4	7.0	18.1	3.2	6.1
Additional research space needed	9.0	4.8	2.5	1.4	0.3	7.1	1.9	4.0	0.6	0.6
Percentage of current research space needed	23	25	21	22	19	21	27	22	18	10
Condition of existing research space [percentage of research space]										
Suitable for use in the most competitive scientific research	48	40	49	67	56	43	32	44	65	44
Effective for most uses but not the most sophisticated	31	36	35	15	25	34	43	31	28	37
Requires major renovation to be used effectively	17	20	14	14	17	18	21	20	6	14
Requires replacement	4	5	2	4	2	5	4	6	1	5

[1] The number of institutions across institution types does not sum to grand totals because many institutions contain both a college/university and a medical school. In grand totals, medical schools are counted as separate institutions only if they are not affiliated with a college or university.

[2] The number of medical schools is based on the sum of the weights of institutions with medical school research space. Medical schools were not an explicit strata in the sampling scheme. Thus, this number may not reflect the actual number of medical schools in the universe.

KEY: NASF = net assignable square feet.

NOTE: Components may not add to totals due to rounding.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

- Research hospitals rated 56 percent (0.8 million NASF) of research space in the biological sciences and 44 percent (2.7 million NASF) of research space in the medical sciences as being in this condition. By contrast, 21 percent (8.2 million NASF) of research space in the biological sciences was rated as needing major renovation or replacement, while 23 percent (7.9 million NASF) of research space in the medical sciences was rated as being in this condition (see table E9-1 for total NASF by field by institution);
- Colleges and universities rated 25 percent (4.8 million NASF) of research space in the biological sciences and 25 percent (1.8 million NASF) of research space in the medical sciences as needing major renovation or replacement;

- Medical schools rated 16 percent (1.9 million NASF) of research space in the biological sciences and 26 percent (4.7 million NASF) of research space in the medical sciences as being in this condition;
- Nonprofit research organizations rated 18 percent (1.2 million NASF) of research space in the biological sciences and 7 percent (0.2 million NASF) of research space in the medical sciences as being in this condition; and
- Research hospitals rated 19 percent (0.3 million NASF) of research space in the biological sciences and 19 percent (1.2 million NASF) of research space in the medical sciences as being in this condition.

Construction of Biomedical Research Space

In fiscal years 1996 and 1997, 172 biomedical research-performing institutions started construction on 7.4 million NASF of research space. During this time period, 116 institutions started construction on 3.5 million NASF of research space in the biological sciences, while 81 institutions started construction on 3.9 million NASF of research space in the medical sciences (table 9-3). Construction projects were started at the different types of biomedical research-performing institutions as follows:

- Among colleges and universities, 89 institutions started construction on 1.9 million NASF of biomedical research space;
- Among medical schools, 47 institutions started construction on 3.4 million NASF of biomedical research space;
- Among nonprofit research organizations, 40 institutions started construction on 1.7 million NASF of biomedical research space; and
- Among research hospitals, 4 institutions started construction on 0.4 million NASF of biomedical research space.

Between 1994–95 and 1996–97, the amount of biomedical research space under construction increased by 74 percent or 3.1 million NASF (from 4.3 million to 7.4 million NASF). During this time period, the medical sciences experienced an appreciable increase of 76 percent (1.7 million NASF) of research space under construction (from 2.2 million to 3.9 million NASF). Among the different institution types, colleges and universities and medical schools experienced a substantial increase in biomedical research space under construction:

- At colleges and universities, the amount of biomedical research space under construction increased by 38 percent or 0.5 million NASF (from 1.4 million to 1.9 million NASF); and
- At medical schools, the amount of biomedical research space under construction increased by 48 percent or 1.1 million NASF (from 2.3 million to 3.4 million NASF).

In fiscal years 1998 and 1999, 203 biomedical research-performing institutions were scheduled to start construction on 10.7 million NASF of biomedical research space. During this time period, 155 institutions were scheduled to start construction on 7.4 million NASF of research space in the biological sciences, while 80 institutions were scheduled to start construction on 3.3 million NASF of research space in the medical sciences.

Construction projects were scheduled to start at the different types of biomedical research-performing institutions as follows:

- Among colleges and universities, 87 institutions were scheduled to begin construction on 3.3 million NASF of biomedical research space;
- Among medical schools, 45 institutions were scheduled to begin construction on 4.3 million NASF of biomedical research space;
- Among nonprofit research organizations, 64 institutions were scheduled to begin construction on 2.4 million NASF of biomedical research space; and
- Among hospitals, 23 institutions were scheduled to being construction on 0.7 million NASF of biomedical research space.

In fiscal years 1996 and 1997, biomedical research-performing institutions committed $2.2 billion to new construction projects costing over $100,000, an increase of 40 percent or $634 million over 1994–95 levels. Slightly more than half of these funds (53 percent or $1.2 billion) were committed to construction projects in the medical sciences, the remaining 47 percent or $1.0 billion were committed to construction projects in the biological sciences.

Table 9-3. Trends in the number of institutions starting biomedical research space construction projects costing more than $100,000, the amount of space constructed, and the cost of construction, by institution type, field, and fiscal year of project start: 1988–98

Fiscal Years	Institution type				All institutions		
	Academic institutions					Field	
	Colleges/ universities	Medical schools[2]	Research organizations	Hospitals	Total	Biological sciences	Medical sciences
Number of institutions starting construction[1]							
1988–89	94	46	18	10	158	--	--
1990–91	82	78	11	9	150	--	--
1992–93	63	54	13	16	151	--	--
1994–95	50	34	11	22	109	--	--
1996–97	89	47	40	4	172	116	81
1998–99 (scheduled)	87	45	64	23	203	155	80
Amount of new research space under construction [NASF in thousands]							
1988–89	1,855	2,660	245	1,057	5,817	2,853	2,982
1990–91	2,431	3,714	547	490	7,183	3,114	4,069
1992–93	1,838	4,175	483	513	7,010	2,686	4,324
1994–95	1,416	2,272	239	333	4,261	2,048	2,213
1996–97	1,949	3,353	1,742	354	7,398	3,496	3,903
1998–99 (scheduled)	3,312	4,340	2,386	678	10,715	7,382	3,333
Cost of new construction projects costing over $100,000 [in millions of constant 1997 dollars]							
1988–89	559	945	94	250	1,849	849	1,000
1990–91	715	1,231	140	193	2,280	1,090	1,189
1992–93	516	1,347	206	301	2,367	909	1,459
1994–95	537	792	71	205	1,605	879	726
1996–97	663	963	450	163	2,239	1,042	1,197
1998–99 (scheduled)	1,018	1,210	707	289	3,224	2,094	1,130

[1] The number of institutions across institution types does not sum to grand totals because many institutions contain both a college/university (exclusive of a medical school) and a medical school. In grand totals, medical schools are counted as separate institutions only if they are not part of larger universities.

[2] The number of medical schools is based on the sum of the weights of institutions with medical school research space. Medical schools were not an explicit strata in the sampling scheme. Thus, this number may not reflect the actual number of medical schools in the universe.

KEY: -- = data unavailable.
NASF = net assignable square feet.

NOTE: Components may not add to totals due to rounding. Current dollars have been adjusted to constant 1997 dollars using the Bureau of Census' Composite Fixed-Weighted Price Index for Construction.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Among the different institution types, only medical schools committed substantially more funds to new construction projects in 1996 and 1997 ($963 million) than they did in fiscal years 1994 and 1995 ($792 million). However, the amount of funds they committed to new construction projects in fiscal years 1996 and 1997 is not substantially different than the amount of funds they committed to these types of projects a decade ago ($945 million).

In fiscal years 1998 and 1999, biomedical research-performing institutions were scheduled to commit $3.2 billion to new construction projects costing over $100,000. This is an increase of 44 percent or $985 million over 1996–97 levels.

Among the different institution types, only colleges and universities are scheduled to commit substantially more funds to new construction projects in fiscal years

1998 and 1999 ($1.0 billion) than they did in fiscal years 1996 and 1997 ($663 million). This is an increase of 54 percent or $355 million.

Repair/Renovation of Biomedical Research Space

In fiscal years 1996 and 1997, 379 biomedical research-performing institutions started repair/renovation projects on 9.0 million NASF of biomedical research space (table 9-4). This represents 21 percent more space under repair/renovation than under construction (see table 9-3). During this time period, 282 institutions began repair/renovation projects on 5.5 million NASF of research space in the biological sciences, while 172 institutions began repair/renovation projects on 3.5 million NASF of research space in the medical sciences.

Between 1994–95 and 1996–97, the amount of biomedical research space repaired or renovated increased by 26 percent or 1.8 million NASF (from 7.1 million to 9.0 million NASF). During this time period, the biological sciences experienced an appreciable increase of 94 percent (2.7 million NASF) of research space under repair/renovation. Among the different institution types, only colleges and universities experienced a substantial increase in the amount of new repair/renovation projects between 1994–95 and 1996–97. The amount of biomedical research space repaired or renovated at colleges and universities increased by 36 percent or 0.8 million NASF (from 2.4 million to 3.2 million NASF).

In fiscal years 1998 and 1999, 251 biomedical research-performing institutions were scheduled to begin repair/renovation projects on 7.7 million NASF of biomedical research space. During this time period, 174 institutions were scheduled to start repair/renovation projects on 4.5 million NASF of research space in the biological sciences, while 130 institutions were scheduled to start repair/renovation projects on 3.2 million NASF of research space in the medical sciences.

In fiscal years 1996 and 1997, biomedical research-performing institutions committed $770 million to new repair/renovation projects costing over $100,000. This was 66 percent or $1.5 billion less than they committed to new construction projects in 1996 and 1997 (see table 9-3). Slightly more than half of these funds (54 percent or $415 million) were committed to repair/renovation projects in the biological sciences, while the remaining 46 percent or $355 million were committed to repair/renovation projects in the medical sciences.

Overall, the amount of funds scheduled to be committed to new repair/renovation projects in 1998 and 1999 was not substantially different from the amount of funds they committed to these types of projects in 1996 and 1997.

In fiscal years 1998 and 1999, biomedical research-performing institutions were scheduled to commit $831 million to new repair/renovation projects. This was 74 percent less than they were scheduled to commit to new construction projects (see table 9-3). Slightly more than half of these funds (51 percent or $424 million) were scheduled to be committed to repair/renovation projects in the biological sciences, the remaining 49 percent ($407 million) were scheduled to be committed to repair/renovation projects in the medical sciences.

Sources of Funds for the Construction of Research Facilities at Biomedical Research-Performing Institutions

In fiscal years 1996 and 1997, State and local governments and debt financing each provided 27 percent of funds for all new science and engineering construction projects costing over $100,000 at biomedical research-performing institutions.[37] Institutional funds and private donations were the source for 19 and 18 percent, respectively, of funds for new construction projects, while the Federal Government contributed 8 percent of all construction funds (see table 9-5).

The largest source(s) of funds for new science and engineering construction projects at the different types of institutions was as follows:

- Colleges and universities derived the majority of their science and engineering construction funds from two sources—37 percent from State and local governments and 21 percent of from debt financing;
- Medical schools derived the majority of their construction funds from three sources—28 percent from institutional funds, 26 percent from State and local governments, and 22 percent from private donations;

[37] Sources of funds were not reported by field. Consequently, the distribution of construction funds across the various sources is for the biomedical fields and all other science and engineering fields (see Chapter 5).

Table 9-4. Trends in the number of institutions starting biomedical research facilities repair/renovation projects costing more than $100,000, the amount of space affected, and the cost of repair/renovation, by institution type, field, and fiscal year of project start: 1988–98

Fiscal Years	Institution type				All institutions		
	Academic institutions					Field	
	Colleges/ universities	Medical schools[2]	Research organizations	Hospitals	Total	Biological sciences	Medical sciences
Number of institutions starting repair/renovation projects[1]							
1988–89	132	76	34	39	241	--	--
1990–91	118	109	45	34	255	--	--
1992–93	121	89	30	34	228	--	--
1994–95	126	86	36	28	231	--	--
1996–97	199	92	76	49	379	282	172
1998–99 (scheduled)	162	62	28	22	251	174	130
Repair/renovation of research space [NASF in thousands]							
1988–89	2,910	2,856	355	333	6,454	3,854	2,600
1990–91	1,682	2,745	516	543	5,486	2,874	2,612
1992–93	1,588	2,542	268	770	5,168	2,848	2,320
1994–95	2,366	3,880	345	540	7,131	2,836	4,295
1996–97	3,207	3,703	1,683	376	8,969	5,498	3,471
1998–99 (scheduled)	4,332	2,759	215	397	7,702	4,523	3,180
Cost of repair/renovation projects costing over $100,000 [in millions of constant 1997 dollars]							
1988–89	228	292	37	92	649	337	419
1990–91	224	344	36	60	664	349	313
1992–93	156	399	43	151	749	409	340
1994–95	196	345	33	137	711	324	387
1996–97	277	360	81	52	770	415	355
1998–99 (scheduled)	357	376	48	50	831	424	407

[1] The number of institutions across institution types does not sum to grand totals because many institutions contain both a college/university (exclusive of a medical school) and a medical school. In grand totals, medical schools are counted as separate institutions only if they are not part of larger universities.

[2] The number of medical schools is based on the sum of the weights of institutions with medical school research space. Medical schools were not an explicit strata in the sampling scheme. Thus, this number may not reflect the actual number of medical schools in the universe.

KEY: -- = data unavailable.
NASF = net assignable square feet

NOTE: Components may not add to totals due to rounding. Current dollars have been adjusted to constant 1997 dollars using the Bureau of Census' Composite Fixed-Weighted Price Index for Construction.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

- Nonprofit research organizations derived the majority of their construction funds from two sources—49 percent from debt financing and 23 percent from State and local governments; and
- Research hospitals derived the majority of their construction funds from one source—91 percent from debt financing.

Sources of Funds for the Repair/Renovation of Research Facilities at Biomedical Research-Performing Institutions

In fiscal years 1996 and 1997, institutional funds were the largest source of funds (50 percent) for new science and engineering repair/renovation projects costing over

Table 9-5. Source of funds for the construction of research facilities at institutions with biomedical research space by year of project start and institution type: 1990–97

Source of funds and year of project start	All biomedical institutions	Institution type			
		Colleges and universities	Medical schools	Research organizations	Hospitals
	Dollar contribution [in millions of constant 1997 dollars]				
1990–91	2,280	715	1,231	140	193
1992–93	2,367	516	1,347	206	301
1994–95	1,605	537	792	71	205
1996–97	2,239	663	963	450	163
	Relative contribution [percentage of total cost]				
Federal Government:					
1990–91	13	19	11	15	0
1992–93	13	14	19	7	1
1994–95	5	4	6	0	0
1996–97	8	11	7	2	0
State and local governments:					
1990–91	21	29	22	2	0
1992–93	24	26	38	0	6
1994–95	35	49	22	0	0
1996–97	27	37	26	23	0
Private donations:					
1990–91	18	10	18	12	46
1992–93	13	12	7	22	16
1994–95	11	9	13	4	17
1996–97	18	16	22	19	4
Debt financing:*					
1990–91	28	30	28	46	0
1992–93	31	23	29	56	43
1994–95	30	26	36	49	61
1996–97	27	21	16	49	91
Institutional funds:					
1990–91	19	8	20	25	54
1992–93	16	21	7	15	7
1994–95	18	11	22	47	22
1996–97	19	14	28	7	5
Other:					
1990–91	1	4	1	0	0
1992–93	3	4	0	0	27
1994–95	0	1	0	0	0
1996–97	1	0	1	0	0

* Category includes tax-exempt bonds and other debt financing as reported in the questionnaire.

NOTES: Components may not add to totals due to rounding. Sources of funds information is not collected by field. Thus, the percentage of funds from each source is based on all S&E expenditures not just expenditures in biomedical fields. Findings are limited to projects with estimated total costs at completion of $100,000 or more for research space. Current dollars have been adjusted to constant 1997 dollars using the Bureau of Census' Composite Fixed-Weighted Price Index for Construction.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

$100,000 at biomedical research-performing institutions.[38] State and local governments were the second largest source of funds (22 percent). Private donations and debt financing each accounted for 9 percent of funds for new repair/renovation projects, while the Federal Government contributed 8 percent of all repair/renovation funds (table 9-6).

The largest source(s) of funds for new science and engineering repair/renovation projects at the different types of institutions was as follows:

- Colleges and universities derived the majority of their science and engineering repair/renovation funds from two sources—45 percent from institutional funds and 26 percent from State and local governments;
- Medical schools derived the majority of their repair/renovation funds from two sources—56 percent from institutional funds and 19 percent from State and local governments;
- Nonprofit research organizations derived the majority of their repair/renovation funds from two sources—53 percent from institutional funds and 21 percent from private donations; and
- Research hospitals derived the majority of their repair/renovation funds from one source—89 percent from institutional funds.

Biomedical Research-Performing Institutions' Need for Research Facilities

In 1998, biomedical research-performing institutions reported $5.6 billion in combined capital projects (construction and repair renovation) that had to be deferred because of insufficient funds. Construction projects accounted for 64 percent ($3.6 billion) of the total deferred capital project costs (both included and not included in an institutional plan) (table 9-7).

Academic institutions accounted for 82 percent ($4.6 billion) of the total deferred costs, whereas nonprofit research organizations accounted for 10 percent ($587 million) and research hospitals account for 7 percent ($419 million).

More than half (61 percent or $2.8 billion) of the deferred costs in academic institutions was at colleges and universities, while the remaining 39 percent or $1.8 billion was at medical schools. Among colleges and universities, the deferred need was distributed as follows:

- The top 50 academic institutions accounted for $1.4 billion or 49 percent of the deferred need at colleges and universities;
- Other doctorate-granting institutions accounted for $1.2 billion or 43 percent of the deferred need; and
- Nondoctorate-granting institutions accounted for $0.2 billion or 9 percent of the deferred need.

More than half of the total deferred capital project costs (56 percent or $3.1 billion) were for projects in the biological sciences, while the remaining 44 percent or $2.5 billion in deferred costs were for projects in the medical sciences. Construction projects (both included and not included in an institutional plan) accounted for 62 percent of the deferred costs in the biological sciences ($1.9 billion) and 67 percent of the deferred costs in the medical sciences ($1.7 billion).

Biomedical Research Facilities at Historically Black Colleges and Universities

The Historically Black Colleges and Universities had 1.6 percent (2.34 million NASF) of all the science and engineering research space in the Nation's research-performing institutions in 1998 (143.3 million NASF) and 1.2 percent (670 thousand NASF) of all the biomedical sciences research space (56.2 million NASF). Overall, 73 percent (490 thousand NASF) of the HBCUs' biomedical sciences research space was in the biological sciences, the other 28 percent (190 thousand NASF) was in the medical sciences. The HBCUs' biomedical sciences research space was distributed unequally across institution types. More than half of the HBCUs' biomedical research space (60 percent or 400 thousand NASF) was located in colleges and universities, while the other 40 percent or 270 thousand NASF was located in medical schools (table 9-8).

Overall, 71 percent of the HBCUs with existing or needed research space in the biomedical sciences reported that the amount of research space they had was inadequate

[38] Ibid.

Table 9-6. Source of funds for the repair/renovation of research facilities at institutions with biomedical research space by year of project start and institution type: 1990–97

Source of funds and year of project start	All biomedical institutions	Institution type			
		Colleges and universities	Medical schools	Research organizations	Hospitals
Dollar contribution [in millions of constant 1997 dollars]					
1990–91	664	224	344	36	60
1992–93	749	156	399	43	151
1994–95	711	196	345	33	137
1996–97	770	277	360	81	52
Relative contribution [percentage of total cost]					
Federal Government:					
1990–91	5	4	5	19	3
1992–93	5	6	7	4	2
1994–95	8	8	7	2	1
1996–97	8	8	6	16	1
State and local governments:					
1990–91	20	33	18	0	2
1992–93	20	25	26	0	2
1994–95	14	15	14	7	0
1996–97	22	26	19	2	0
Private donations:					
1990–91	14	16	15	8	6
1992–93	8	10	9	15	2
1994–95	15	14	11	10	32
1996–97	9	9	8	21	10
Debt financing:*					
1990–91	10	2	14	16	8
1992–93	15	23	7	0	32
1994–95	13	14	16	28	8
1996–97	9	9	10	8	0
Institutional funds:					
1990–91	51	45	48	57	81
1992–93	50	35	48	81	62
1994–95	46	45	51	47	39
1996–97	50	45	56	53	89
Other:					
1990–91	0	0	0	0	0
1992–93	2	1	3	0	0
1994–95	3	4	0	6	21
1996–97	2	2	2	0	0

* Category includes tax-exempt bonds and other debt financing as reported in the questionnaire.

NOTES: Components may not add to totals due to rounding. Sources of funds information is not collected by field. Thus, the percentage of funds from each source is based on all S&E expenditures not just expenditures in biomedical fields. Findings are limited to projects with estimated total costs at completion of $100,000 or more for research space. Current dollars have been adjusted to constant 1997 dollars using the Bureau of Census' Composite Fixed-Weighted Price Index for Construction.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Table 9-7. Estimated costs for deferred capital projects to construct or repair/renovate biomedical research facilities by institution type, type of project, and whether project was included in an institutional plan: 1998

Institution type	Included in institutional plans			Not included in institutional plans			Total
	To construct new research facilities	To repair/ renovate existing research facilities	Subtotal	To construct new research facilities	To repair/ renovate existing research facilities	Subtotal	
	In millions of dollars						
Total	2,680	1,177	3,857	917	836	1,753	5,610
Academic institutions	2,265	1,067	3,332	493	780	1,272	4,604
Colleges/universities	1,309	634	1,943	344	521	865	2,808
Top 50	605	296	901	200	261	461	1,362
Other doctorate-granting	564	246	810	140	253	393	1,204
Nondoctorate-granting	140	92	232	4	7	11	243
Medical schools	955	434	1,389	149	258	407	1,796
Research organizations	178	78	256	314	17	331	587
Hospitals	238	32	270	110	40	150	419
Field							
Biological sciences	1,398	747	2,144	529	448	977	3,121
Medical sciences	1,283	431	1,714	388	388	776	2,490

KEY: NASF = net assignable square feet.

NOTE: Components may not add to totals due to rounding.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

to meet their current biomedical research commitments. Sixty-seven percent of all academic institutions reported inadequate amounts of biomedical research space.

With respect to the condition of their biomedical research space, the HBCUs rated 47 percent (315 thousand NASF) of their biomedical research space as "suitable for the most scientifically sophisticated research," whereas 45 percent of the biomedical research space at all academic institutions was rated this way. By contrast, the HBCUs rated 8 percent (54 thousand NASF) of their biomedical research space as needing major repair/renovation or replacement, whereas 21 percent of the biomedical research space at all academic institutions was reported as being in this condition.

In fiscal years 1996 and 1997, 6 HBCUs began construction on 111 thousand NASF of biomedical research space at an expected completion cost of $31 million. In 1998 and 1999, 8 HBCUs were scheduled to begin construction on 139 thousand NASF of biomedical research space at an expected completion cost of $40 million.

Similarly, in fiscal years 1996 and 1997, 8 HBCUs began new repair/renovation projects on 93 thousand NASF of biomedical research space at an expected completion cost of $6.0 million. In 1998 and 1999, 6 HBCUs were scheduled to begin new repair/renovation projects on 223 thousand NASF of biomedical research space at an expected completion cost of $8.9 million.

Animal Research Facilities at Biomedical Research-Performing Institutions

In 1998, 700 of the 908 biomedical research-performing institutions (77 percent) had animal laboratory facilities. While 85 percent of the academic

Table 9-8. Amount, condition, adequacy, construction, and repair/renovation of biomedical research facilities at Historically Black Colleges and Universities (HBCUs) compared to all academic institutions: 1998

Indicator	HBCUs	All academic institutions*
Number of institutions	57	660
Amount of S&E research space [NASF in millions]		
All S&E fields	2.34	143.3
Biomedical sciences, total	0.67	56.2
Colleges and universities	0.40	26.4
Biological sciences	0.31	19.4
Medical sciences	0.10	7.0
Medical schools	0.27	29.8
Biological sciences	0.18	11.6
Medical sciences	0.09	18.1
Adequacy of current amount of biomedical research space [percentage of institutions]		
Sufficient to support needs of current biomedical research program commitments	29	33
Not sufficient to support needs of current biomedical research program commitments	71	67
Condition of existing biomedical research space [percentage of space]		
Suitable for use in the most sophisticated scientific research	47	45
Effective for most uses but may need limited repair	45	33
Requires major repair/renovation to be used effectively	7	17
Requires replacement	1	4
Construction projects: fiscal years 1996–97		
Number of institutions with projects >$100,000	6	128
Biomedical research space to be constructed [NASF in thousands]	111	5,303
Expected cost [in thousands of dollars]	31,258	1,625,638
Sources of funds for all construction projects [percentage of total cost]		
Federal Government	7	9
State and local governments	76	31
Private donations	5	19
Institutional funds	2	19
Debt financing	7	21
Other	3	1
Scheduled construction projects: fiscal years 1998–99		
Number of institutions planning projects >$100,000	8	117
Biomedical research space to be constructed [NASF in thousands]	139	7,652
Expected cost [in thousands of dollars]	40,195	2,227,605
Repair/renovation projects: fiscal years 1996–97		
Number of institutions with projects >$100,000	8	244
Biomedical research space to be repaired or renovated [NASF in thousands]	93	6,897
Expected cost [in thousands of dollars]	6,042	637,046
Scheduled repair/renovation projects: fiscal years 1998–99		
Number of institutions planning projects >$100,000	6	189
Biomedical research space to be repaired or renovated [NASF in thousands]	223	7,927
Expected cost [in thousands of dollars]	8,850	732,933

* Includes all academic institutions, with and without biomedical research space.

KEY: NASF = net assignable square feet.
S&E = science and engineering

NOTE: Components may not add to totals due to rounding.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

institutions and 80 percent of the research hospitals had animal laboratory facilities, less than half (46 percent) of the nonprofit research organizations had such facilities (table 9-9).

The biomedical research-performing institutions reported a total of 14 million NASF of animal research space at biomedical research-performing institutions. Most of that space (83 percent or 12 million NASF) was located in the academic institutions. The nonprofit research organizations accounted for 12 percent of all the animal research space (1.7 million NASF), while the research-performing hospitals account for 5 percent (0.7 million NASF). The majority of animal research space (71 percent or 10 million NASF) was animal housing space, the remaining 29 percent (4 million NASF) was animal research space.

Institutions with animal research space reported that 69 percent (9.8 million NASF) of that space was at Federal biosafety Level 1 (i.e., acceptable for work with microorganisms not known to cause disease in healthy humans). Another 28 percent (4.0 million NASF) of that space was at Level 2 (i.e., acceptable for work with moderate-risk agents present in the community and associated with human disease of varying severity), and 4 percent (0.6 million NASF) was at Level 3 (i.e., acceptable for work with indigenous or exotic agents with a potential for respiratory transmission, and which may cause serious and potentially lethal infection). No biomedical research-performing institution had animal research space at Level 4 (i.e., acceptable for work with biological agents that may cause the transmission of a potentially lethal disease for which there is no readily available cure).

Overall, 88 biomedical research-performing institutions were scheduled to start construction on 1.2 million NASF of animal research facilities at an estimated cost of $462 million in 1998 and 1999. The scheduled construction projects across institution types were as follows:

- Among academic institutions, 35 institutions were scheduled to start construction on 492 thousand NASF of animal research space at an estimated cost of $162 million in 1998 and 1999;
- Among nonprofit research organizations, 45 institutions were scheduled to start construction on 422 thousand NASF of animal research space at an estimated cost of $143 million 1998 and 1999; and
- Among research hospitals, 8 institutions were scheduled to start construction on 242 thousand NASF of animal research space at an estimated cost of $157 million in 1998 and 1999.

Similarly, 69 biomedical research-performing institutions were scheduled to start repair/renovation projects on 350 thousand NASF of animal research space at an estimated cost of $69 million in 1998 and 1999. The scheduled repair/renovation projects across institutions types were as follows:

- Among academic institutions, 56 institutions were scheduled to start repair/renovation projects on 303 thousand NASF of animal research space at an estimated cost of $45 million in 1998 and 1999;
- Among nonprofit research organizations, 6 institutions were scheduled to start repair/renovation projects on 28 thousand NASF of animal research space at an estimated cost of $7 million 1998 and 1999; and
- Among research hospitals, 7 institutions were scheduled to start repair/renovation projects on 20 thousand NASF of animal research space at an estimated cost of $18 million in 1998 and 1999.

Table 9-9. Amount, biosafety level, and scheduled construction and repair/renovation of animal research space at institutions with biomedical research space by institution type: 1998

Indicator	All biomedical institutions[5]	Institution type		
		Academic institutions[6]	Research organizations	Hospitals
Number of biomedical institutions, 1998	908	612	171	125
Number of biomedical institutions with animal research facilities, 1998	700	522	78	100
Total animal research space [NASF in thousands]	14,227	11,829	1,674	723
Animal housing space	10,161	8,532	1,149	480
Animal laboratory space	4,066	3,297	526	243
Percentage of animal research space at each biological safety level				
Level 1[1]	69	75	33	55
Level 2[2]	28	23	61	34
Level 3[3]	4	3	6	11
Level 4[4]	0	0	0	0
Scheduled construction of animal research space: 1998–99				
Number of biomedical institutions with scheduled construction	88	35	45	8
Amount of animal research space scheduled to be constructed [NASF in thousands]	1,156	492	422	242
Estimated cost of construction of animal research space [in millions of current dollars]	462	162	143	157
Scheduled repair/renovation of animal research space: 1998–99				
Number of biomedical institutions with scheduled repair/renovations costing over $100,000	69	56	6	7
Amount of animal research space scheduled to be repaired or renovated [NASF in thousands]	350	303	28	20
Estimated cost of repair/renovation of animal research space [in millions of current dollars]	69	45	7	18

[1] Acceptable for work with microorganisms not known to cause disease in healthy humans.

[2] Acceptable for work with moderate-risk agents present in the community and associated with human disease of varying severity.

[3] Acceptable for work with indigenous or exotic agents with a potential for respiratory transmission, and which may cause serious and potentially lethal infection.

[4] Acceptable for work with biological agents that may cause the transmission of a potentially lethal disease for which there is no readily available cure.

[5] Includes only institutions with biomedical research space.

[6] Includes colleges, universities, and medical schools.

KEY: NASF = net assignable square feet.

NOTES: Components may not add to totals due to rounding. Animal research space was reported in total, not separately for each science and engineering field. Therefore, the animal space figures apply to all science and engineering fields, not solely to biomedical fields.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.